Japan Patent 8-167424

Solid High Polymer Electrolyte Fuel Battery

Translation from Japanese

LNBT/ah

ICA Translations Number 32 845

International Communications And Translations, Inc.
614 South 8th Street #304, Philadelphia, PA 19147
Tel: 215-922-1567 • Fax: 215-922-1789

(19) Japan Patent Office (JP)
(12) Laid-Open Patent Report (A)
(11) Laid-open patent application no.
H8-167424
(43) Date laid open: June 25, 1996

(51) Int. Cl.[6]:	Identification code:		FI Technical Display Location Internal control no.:
H 01 M 8/10			9444-4K
8/02		C	9444-4K
8/24		R	9444-4K

Inspection requested: No
Number of claims: 5
(Total 15 pages)

(21) Application no.: H6-308510
(22) Application date: December 13, 1994
(71) Applicant: 000005234
Fuji Electric Co., Ltd.
1-1 Tanabe-Shinden, Kawasaki-ku, Kawasaki City, Kanagawa Prefecture
(72) Inventor: Satoru SHIGA
Fuji Electric Co., Ltd., 1-1 Tanabe-Shinden, Kawasaki-ku, Kawasaki City, Kanagawa Prefecture
(72) Inventor: Kazuki YANAGIUCHI
Fuji Electric Co., Ltd., 1-1 Tanabe-Shinden, Kawasaki-ku, Kawasaki City, Kanagawa Prefecture
(74) Agent: Iwao YAMAGUCHI, Patent Agent

---

(54) {Title of the Invention} Solid high polymer electrolyte fuel battery

(57) {Summary}

{Purpose} To provide a solid high polymer electrolyte fuel battery in which the temperature distribution is easily made uniform in the direction of layering of the unit fuel batteries.

{Structure} The solid high polymer electrolyte fuel battery (stack) 1 differs from the conventional example in that exothermic bodies 2, in which the electrical current output from the stack 1 flows in the direction of thickness, are in the form of a thin sheet, and moreover, are sandwiched between a collector sheet 91 and the unit fuel battery 6 that is adjacent to this collector sheet 91. The exothermic bodies 2 are such that a thin sheet of electrothermic alloy material, whose volume resistivity is 1.0-1.5 μΩ-m, is formed having the same surface area as the surface area direction dimension of the oxidizer electrode and fuel electrode of the unit fuel battery 6, and the thickness of the exothermic bodies 2 is determined by the current output from the stack 1 such that the joule heat value produced by the exothermic bodies 2 is a value that corresponds to the heat quantity radiated from the ends in the layered direction of the stack 1.

{Scope of the Patent Claims}

{Claim 1} In a solid high polymer electrolyte fuel battery that has multiple unit fuel batteries that have a fuel battery cell that generates DC power by receiving a supply of fuel gas and oxidizer gas, and a pair of separators in which gas flow channels are formed for supplying fuel gas or oxidizer gas to the fuel battery cell and are arranged opposite the two main faces of the fuel battery cell, and these unit fuel batteries are made into a layered body of unit fuel batteries in which adjacent unit fuel batteries are layered with each other such that the side face on the reaction gas passage channel side of one separator is located opposite the side face on the reaction gas passage channel side of the separator of an adjacent unit fuel battery; and that has collector sheets made of electrically conductive material in contact with the outside faces of the separators located on at least both ends of the layered body of unit fuel batteries; and electrical insulation sheets of these collector sheets that are made of electrically insulating material and are in contact with the outside faces of the collector sheets located at least on both ends of the layered body of unit fuel batteries; and pressurizing sheets of these electrically insulating sheets that provide pressure force to the layered body, collector sheets and electrical insulation sheets of the unit fuel batteries in the direction of layering, and that are in contact with the outside faces of the electrical insulation sheets located on at least the two ends of the layered body of unit fuel batteries; and piping connectors for cooling fluid provided in locations to supply and locations to drain cooling fluid that removes heat generated by the fuel battery cell; and the cooling fluid that removes heat generated by the fuel battery cell is supplied from outside the layered body of unit fuel batteries via a piping connector for supply of the cooling fluid, and after cooling the unit fuel batteries, is drained to outside the layered body of unit fuel

batteries via a piping connector for drainage of the cooling fluid; a solid high polymer electrolyte fuel battery characterized in that exothermic bodies heated by the electrical current output by the solid high polymer electrolyte fuel battery are formed at locations on the collector sheets that are in contact with the outside faces of the separators located at least on the two ends of the layered body of unit fuel batteries.

{Claim 2} In the solid high polymer electrolyte fuel battery as stated in Claim 1, a solid high polymer electrolyte fuel battery characterized in that the exothermic bodies formed at locations on the collector sheets are exothermic bodies made of resistive material in the form of thin sheets sandwiched between the layered body of unit fuel cells and the collector sheets.

{Claim 3} In the solid high polymer electrolyte fuel battery as stated in Claim 1, a solid high polymer electrolyte fuel battery characterized in that the exothermic bodies formed at locations on the collector sheets are collector sheets made of resistive material.

{Claim 4} In a solid high polymer electrolyte fuel battery that has multiple unit fuel batteries that have a fuel battery cell that generates DC power by receiving a supply of fuel gas and oxidizer gas, and a pair of separators in which gas flow channels are formed for supplying fuel gas or oxidizer gas to the fuel battery cell and are arranged opposite the two main faces of the fuel battery cell, and these unit fuel batteries are made into a layered body of unit fuel batteries in which adjacent unit fuel batteries are layered with each other such that the side face on the reaction gas passage channel side of one separator is located opposite the side face on the reaction gas passage channel side of the separator of an adjacent unit fuel battery; and that has collector sheets made of electrically conductive material in contact with the outside faces of the separators located on at least both ends of the layered body of unit fuel batteries; and electrical

insulation sheets of these collector sheets that are made of electrically insulating material and are in contact with the outside faces of the collector sheets located at least on both ends of the layered body of unit fuel batteries; and pressurizing sheets of these electrically insulating sheets that provide pressure force to the layered body, collector sheets and electrical insulation sheets of the unit fuel batteries in the direction of layering, and that are in contact with the outside faces of the electrical insulation sheets located on at least the two ends of the layered body of unit fuel batteries; and piping connectors for cooling fluid provided in locations to supply and locations to drain cooling fluid that removes heat generated by the fuel battery cell; and the cooling fluid that removes heat generated by the fuel battery cell is supplied from outside the layered body of unit fuel batteries via a piping connector for supply of the cooling fluid, and after cooling the unit fuel batteries, is drained to outside the layered body of unit fuel batteries via a piping connector for drainage of the cooling fluid; a solid high polymer electrolyte fuel battery characterized in that the collector sheets have heating means heated by the cooling fluid of which the temperature has been raised by cooling the unit fuel batteries.

{Claim 5} In the solid high polymer electrolyte fuel battery as stated in Claim 4, a solid high polymer electrolyte fuel battery characterized in that the heating means of the collector sheets are flow passages for cooling fluid, formed inside the collector sheets, through which flows cooling fluid of which the temperature has been raised by cooling of the unit fuel batteries.

{Detailed Explanation of the Invention}

{0001}

{Industrial Field of Us } This invention pertains to solid high polymer electrolyte fuel batteries, and pertains to their structure which has been

improved such that the temperature distribution of the fuel battery cells of the unit fuel batteries in the direction of layering of the unit fuel batteries is easily made uniform.

{0002}

{Prior Art} Various types of fuel batteries are known, which differ depending on the type of electrolyte used, such as those of the solid high polymer electrolyte type, phosphoric acid type, fused calcium carbonate type, solid oxide type and so forth. Among these, solid high polymer electrolyte fuel batteries make use of the fact that when a high polymer resin film that has proton (hydrogen ion) exchange radicals in its molecules is saturated with water, it exhibits low resistivity, and it functions as a proton-conducting electrolyte. As high polymer resin films (referred to below as "solid high polymer electrolyte films" or abbreviated as "PE films") that have proton exchange radicals in their molecules, those in which polystyrene-based cation exchange film that has sulfonic acid radicals is used as a cation conductive film, or perfluorosulfonic acid resin films (for example, product name Nafion made by Dupont) are used. When these solid high polymer electrolyte films (PE films) are saturated with water, they exhibit resistivity below 20 Ω-cm at room temperature, and they function as proton-conducting electrolytes.

{0003} In a solid high polymer electrolyte fuel battery, a fuel electrode (the anode) and an oxidizer electrode (the cathode) are arranged sandwiching this PE film, and fuel gas (for example, hydrogen or gas that contains hydrogen in high concentration) is supplied to this fuel electrode, and an oxidizer gas (for example, air) is supplied to the oxidizer electrode. In the fuel electrode and oxidizer electrode, a three-phase boundary is formed between the gas phase (fuel gas or oxidizer gas), the liquid phase (solid high polymer electrolyte) and the solid phase (catalysts of the fuel electrode and oxidizer electrode), and the

electrochemical reaction shown below occurs, thereby generating DC power. That is, the reaction of equation (1) occurs in the fuel electrode.

{0004}

{Equation 1}

$H_2 \rightarrow 2H^+ + 2e^-$ (1)

Also, the reaction of equation (2) occurs in the oxidizer electrode.

{0005}

{Equation 2}

$(1/2)O_2 + 2H^+ + 2e^- \rightarrow H_20$ (2)

As a result of this reaction, the H^+ ions (protons) generated by the fuel electrode move in the PE film toward the oxidizer electrode, and the e^- (electrons) generated by the fuel electrode move from the fuel electrode to the oxidizer electrode, passing through a load not shown in the diagram connected between the fuel electrode and oxidizer electrode. On the other hand, in the oxidizer electrode, the H^+ ions that moved in the PE film from the fuel electrode and the e^- that moved through the load react, and water (H_2O) is generated.

{0006} Figure 6 is a side-view cross-sectional diagram that schematically shows, in the exposed state, the important parts of a general example of a unit fuel battery that performs the above operations. Figure 7 is an oblique diagram that schematically shows the unit fuel battery of Figure 6 in the exposed state, and Figure 8 is a diagram of a separator of the unit fuel battery seen from the direction of arrow P in Figure 6.

{0007} In Figures 6-8, 6 is a unit fuel battery (referred to below as "unit battery") constructed of a fuel battery cell 7 and separators 61 and 62 arranged on its two main surfaces opposing each other. The fuel battery cell 7 is constructed of a PE film 7C as the electrolyte layer, a fuel electrode 7A, and an

oxidizer electrode 7B, and it has the function of generating DC power as described above. Also, the PE film 7C has a thickness dimension of about 0.1 mm, and it has an external dimension in the surface direction that is larger than the external dimension in the surface direction of electrode films 7A and 7B. Therefore, on the periphery of the electrode films 7A and 7B, there is an exposed surface of the PE film 7C.

{0008} The fuel electrode 7A is layered in direct contact with one of the main surfaces of the PE film 7C, and it is the electrode that receives supply of fuel gas. Also, the oxidizer electrode 7B is layered in direct contact with the other main surface of the PE film 7C, and it is the electrode that receives supply of oxidizer gas. The outer side face of the fuel electrode 7A is one of the side faces 7a of the fuel battery cell 7, and the outer side face of the oxidizer electrode 7B is the other side face 7b of the fuel battery cell 7. The fuel electrode 7A and oxidizer electrode 7B both have an electrode base and a catalyst layer that contains a catalytic substance, and they are generally attached to the two main surfaces of the PE film 7C by hot press on the side toward the aforementioned catalyst layer. The electrode base supports the catalyst layer, and also supplies and drains reaction gas (below, this is a general name for both fuel gas and oxidizer gas), and it uses carbon paper, for example, as a porous sheet that functions as a collector. In many cases the catalyst layer is formed from fine-particle platinum catalyst and fluororesin that is water-repellent. Moreover, it is also possible to perform catalysis over a wide area with respect to the reaction gas by making it so that many pores are formed in the layer. Also, the thickness dimension of the fuel battery cell 7, which is a combination of the fuel electrode 7A, PE film 7C and oxidizer electrode 7B, is approximately 1 mm in many cases.

{0009} Also, through-holes 71 formed in the exposed surface of the PE film 7C are formed opposite through-holes 615A and 616A provided in the separator 61

and through-holes 625A and 626A provided in the separator 62, and they are holes that make up part of the flow passage of the reaction gas. Similarly, through-holes 72 formed in the exposed surface of the of the PE film 7C are formed opposite through-holes 613B and 614B provided in the separator 61 and through-holes 623B and 624B provided in the separator 62, and they are holes that make up part of the flow passage of the cooling fluid 99 described below.

{0010} Incidentally, in the fuel battery cell 7, when DC power is generated by the electrochemical reaction shown in the aforementioned equation (1) and equation (2), because this reaction is an exothermic reaction, it is unavoidable that heat is generated with about the same value as the DC power that is generated. For this reason, not only do separator 61 and separator 62 supply reaction gas to the fuel battery cell 7, they also serve the purposes of extracting from the fuel battery cell 7 the DC power generated by the fuel battery cell 7, as well as removing the heat generated by the fuel battery cell 7 following the generation of DC power.

{0011} The side face 61a of the separator 61 directly contacts the side face 7a of the fuel battery cell 7 and the side face 62a of the separator 62 directly contacts the side face 7b of the fuel battery cell 7, so as to sandwich the fuel battery cell 7. The separators 61 and 62 are manufactured using materials that are impermeable to gas and have good thermal conductivity and good electrical conductivity (for example, carbon, metals and the like).

{0012} As a means that supplies reaction gas to the fuel battery cell 7, the separators 61 and 62 each have channels for gas flow. That is, on the side of the side surface 61a that contacts the side face 7a of the fuel battery cell 7, the separator 61 has multiple concave channels (gas flow channels) 611A that have spaces through which fuel gas flows and fuel gas that contains unconsumed hydrogen is drained, and convex barriers 612A interposed between these

channels 611A in an alternating manner. On the side of the side face 62a that contacts the side face 7b of the fuel battery cell 7, the separator 62 has multiple concave channels (gas flow channels) 621A that have spaces through which oxidizer gas flows and oxidizer gas that contains unconsumed oxygen is drained, and convex barriers 622A interposed between these channels 621A in an alternating manner. Furthermore, the heads of the convex barriers 612A and 622A, respectively, are formed such that they are the same surface as the side faces 61a and 62a, of the separators 61 and 62, respectively.

{0013} The two ends of the channels 621A formed in the separator 62 connect to channels 624A and 624A, with these channels 621A lined up alternately. On the ends of these channels 624A and 624A, a pair of through-holes 625A and 625A are formed on the side of the side face 62b, which is opposite the side face 62a. Also, on the separator 62, a pair of through-holes 626A and 626A, which connect the side face 62a with the side face 62b, are formed in locations so as to have an alternating positional relationship with the through-holes 625A and 625A. Channels 621A, channels 624A and through-holes 625A constitute the gas flow passage through which oxidizer gas flows in the separator 62.

{0014} Also, through-holes 615A and 615A and through-holes 616A and 616A are formed on the separator 61 as well. That is, the two ends of the channels 611A formed on the separator 61 connect to channels of the same type as channels 624A and 624A in the case of the separator 62. On the ends of these channels (which have the same shape as 624A), through-holes 615A and 615A are formed on the side of the side face 61b, which is opposite the side surface 61a. The through-holes 616A and 616A connect the side face 61a with the side face 61b, and are formed in locations so as to have an alternating positional relationship with the through-holes 615A and 615A, as shown in Figure 7(a). Channels 611A, the aforementioned channels (which have the same shape as

624A) and through-holes 615A constitute the gas flow passage through which fuel gas flows in the separator 61.

{0015} In addition, 73 is a gas seal (for example, an O-ring) made of an elastic material that serves the purpose of preventing leakage of the reaction gas that flows in the aforementioned gas flow passage to outside the gas flow passage. Gas seals 73 are housed in concave channels 619 and 629 formed on the periphery of the locations where the channels 611A and 624A and the channels of the same shape as channels 611A and 624A of the separators 61 and 62, respectively, are formed. Furthermore, although that which is shown in the diagram is abridged, there are concave channels for housing gas seals (for example, O-rings) made of an elastic material that serve the purpose of preventing leakage of the reaction gas from these locations to outside the gas flow passage. These gas seals are wrapped around the openings to the side face 61b of the through-holes 615A and 616A and the openings to the side face 61a of 616A of the separator 61, and it is wrapped around the openings to the side face 62b of the through-holes 625A and 626A and the openings to the side face 62a of 626A of the separator 62.

{0016} Also, as a cooling means for removing heat generated by the fuel battery cell 7 from the fuel battery cell 7, the separators 61 and 62 have channels through which a cooling fluid 99 passes. That is, on the side face 62b of the separator 62, two concave channels 621B (channels for flow of cooling fluid 99) are formed, through which the cooling fluid 99 passes. On both ends of each channel 621B, a pair of through-holes 623B and 624B that opens to the side face 62a is formed. Channels 621B and through-holes 623B and 624B constitute the cooling means through which cooling fluid 99 flows in the separator 62. Also, in the separator 61, similar to the separator 62, two concave channels 611B (channels for flow of cooling fluid 99) are formed on the side face 61b. On both

ends of each channel 611B, a pair of through-holes 613B and 614B opens to the side face 61a. On both ends of each channel 611B, a pair of through-holes 613B and 614B that opens to the side face 61a is formed. Channels 611B and through-holes 613B and 614B constitute the cooling means through which cooling fluid 99 flows in the separator 61.

{0017} On the side face 61b of separator 61 and the side face 62b of separator 62, concave channels 618B and 628B are formed surrounding the channels 611B and 621B, respectively. These concave channels are for housing seals (for example, O-rings) made of elastic material for preventing leakage of the cooling fluid 99. Furthermore, although what is shown in the diagram is abridged, there are concave channels for housing gas seals (for example, O-rings) made of an elastic material that serve the purpose of preventing leakage of the cooling fluid 99 from this location to outside the cooling means. These gas seals are wrapped around the openings to the side face 61a of the through-holes 613B and 614B of the separator 61, and around the openings to the side face 62a of the through-holes 623B and 624B of the separator 62.

{0018} Since the voltage generated by one fuel battery cell 7 is a low value less than 1 volt, many (from several dozen to several hundred) of the unit batteries 6 that have the aforementioned structure are constructed as a layered body of unit batteries that are alternately layered in series such that the generated voltage of the fuel battery cell 7 is reliably provided with increased voltage. Figure 9 is a structural diagram that schematically shows the major parts of a solid high polymer electrolyte fuel battery of the past, where (a) is a side-view diagram, and (b) is a top-view diagram. Also, Figure 10 is an explanatory diagram that explains the cooling fluid flow passages provided in the solid high polymer electrolyte fuel battery shown in Figure 9. Furthermore, in Figure 9, only

representative code numbers are shown for the code numbers used in Figures 6-8.

{0019} In Figure 9, 9 is a solid high polymer electrolyte fuel battery (referred to below as "stack") whose main body is layers of unit batteries 6 constructed by layering multiple unit batteries 6 (Figure 9 shows the case where the number of unit batteries 6 is eight). In the stack 9, collector sheets 91 and 91 made of electrically conductive material such as copper for extracting the DC power generated by the unit batteries 6 from the stack 9, electrical insulation sheets 92 and 92 made of electrically insulating material for electrically insulating the unit batteries 6 and collector sheet 91, and pressurizing sheets 93 and 94 made of a metal such as steel arranged on the outside surfaces of the two electrical insulation sheets 92, are layered sequentially. An appropriate degree of pressure is applied to the pressurizing sheets 93 and 94 from the two outside surfaces by means of multiple fastening bolts 95.

{0020} In unit batteries 6 adjacent to each other, the through-hole 615A formed in the separator 61 and the through-hole 626A formed in the separator 62 are formed so that their openings coincide with each other, as are the through-hole 616A formed in the separator 61 and the through-hole 625A formed in the separator 62. Also, through-holes not shown in the diagram are formed in the collector sheets 91, electrical insulation sheets 92 and pressurizing sheet 93 in the locations opposite through-holes 615A and 616A of the separator 61. In addition, through-holes not shown in the diagram are formed in the collector sheets 91, electrical insulation sheets 92 and pressurizing sheet 94 in the locations opposite through-holes 625A and 626A of the separator 62. By these through-holes, when multiple unit batteries 6 are layered, the respective fuel gas flow passages and oxidizer gas flow passages of all of the unit batteries 6 form continuous passages connected to each other.

{0021} Also, in unit batteries 6 adjacent to each other, the through-hole 613B formed in the separator 61 and the through-hole 623B formed in the separator 62 are formed so that their openings coincide with each other, as are the through-hole 614B formed in the separator 61 and the through-hole 624B formed in the separator 62. Also, through-holes not shown in the diagram of the same type as through-hole 613B are formed in the collector sheets 91, electrical insulation sheets 92 and pressurizing sheet 94 in the locations opposite through-holes 613B of the separator 61. In addition, on the side face of the pressurizing sheet 93 that becomes the outside of the stack 9, piping connectors 98 for the cooling fluid 99 are connected, opposite the respective through-holes. Also, concave channels are formed wrapping around the openings of the through-holes on both sides of the electrical insulation sheet 92 and around the openings of the through-holes on the side face to which the piping connectors 98 of the pressurizing sheet 93 are attached. In these channels there are gas seals (for example, O-rings) made of an elastic material not shown in the diagram, which serve the purpose of preventing leakage of cooling fluid 99 from these locations to outside the cooling means. Furthermore, seals not shown in the diagram are also mounted in the channels 618B formed on the separator 61.

{0022} In addition, through-holes and channels not shown in the diagram are formed in the collector sheets 91, electrical insulation sheets 92 and pressurizing sheet 94 in locations opposite the through-holes 624B of the separator 62 in the same way as above. Also, on the side face of the pressurizing sheet 94 that becomes the outside of the stack 9, piping connectors 98 for the cooling fluid 99 are connected, opposite the respective through-holes. Seals not shown in the diagram are mounted in these channels, and seals not shown in the diagram are also mounted in the channels 628B formed in the separator 62. Thus, when multiple unit batteries 6 are layered, the respective oxidizer gas flow passages of

the unit batteries 6 form continuous passages connected to each other, as shown in Figure 10.

{0023} As a result, the cooling fluid 99 first flows into one channel 611B formed in the separator 61 of the unit battery 6 adjacent to the collector sheet 91, via the piping connector 98 (marked as "inlet" in Figure 10) attached to the pressurizing sheet 93. Then, it is distributed into the channels 611B and 621B of each unit battery 6 via through-holes 613B and 623B, and then it flows out to outside the stack 9, via through-holes 614B, 624B and so forth, from the piping connector 98 attached to the pressurizing sheet 94. This cooling fluid 99 that has flowed out flows in the piping 97, and then again flows into the stack 9 from the other piping connector 98 attached to the pressurizing sheet 94. This cooling fluid 99 flows into the other channel 621B formed in the separator 62 of the unit battery 6 adjacent to the collector sheet 91. Then, it is distributed in the other channels 611B and 621B of the unit batteries 6 via through-holes 614B and 624B, and then drained to outside the stack 9, via through-holes 613B and 623B, from the other piping connector 98 attached to the pressurizing sheet 93 (marked as "outlet" in Figure 10).

{0024}The fastening bolts 95 are hexagonal bolts extending over the pressurizing sheets 93 and 94. The respective fastening bolts 95 act in concert with plate springs and the like for providing stable pressurizing force to the hexagonal nuts and so forth that fit on them, pressurizing the unit batteries 6 in their direction of layering. The pressurizing force that these fastening bolts 95 apply to the unit batteries 6 is generally about 5 kg/cm^2 for the apparent surface area of the fuel battery cell 7.

{0025} In the stack 9 constructed in this way, the reaction gas flows from top to bottom with respect to the direction of gravity, as shown by the arrow in Figure 9 (a), in the gas flow channels 611A and 621A formed in the respective

separators 61 and 62. Moreover, the reaction gas is supplied in parallel to the multiple unit batteries 6. Also, a PE film 7C used in the fuel battery cell 7 is a film that functions as an electrolyte with good proton conductivity due to the fact that it is saturated with water as described above, and therefore the reaction gas is supplied to the stack 9 while being humidity-adjusted to an appropriate degree of humidity.

{0026} To remove the aforementioned heat generated by the fuel battery cell 7 of a unit batteries 6, cooling fluid 99, which is tap water, for example, is supplied to the stack 9. The fuel battery cell 7 is cooled via separators 61 and 62 due to the fact that, in the unit batteries 6, this cooling fluid 99 flows in the respective channels 611B and 621B formed in the separators 61 and 62 as described previously using Figure 10 and so forth. As a result, the fuel battery cell 7 generally operates in a temperature range of 70-80°C.

{0027} Furthermore, the number of channels 611B and 621B provided in the separators is appropriately selected to correspond more or less to the DC power value generated by one fuel battery cell 7, for example, and therefore cases are known where the separators have four each of channels 611B and 621B. Figure 11 is a top-view diagram that schematically shows the structure of the major parts of a different solid high polymer electrolyte fuel battery of the past that uses unit fuel batteries that have this type of separator. Also, Figure 12 is a diagram of the separator used in Figure 11 as seen from the direction of arrow Q in Figure 11. In Figures 11 and 12, the same code numbers are given to the same parts as the unit fuel battery for a solid high polymer electrolyte fuel battery shown in Figures 6-8 and the solid high polymer electrolyte fuel battery of the past shown in Figure 9, and therefore their explanations are omitted. Furthermore, in Figure 11, only representative code numbers are shown for the code numbers used in Figures 6-9 and Figure 12.

{0028} In Figures 11 and 12, 9A is a solid high polymer electrolyte fuel battery (referred to below as "stack") that uses unit fuel batteries 6A (referred to below as "unit batteries"), collector sheets 91A, electrical insulation sheets 92A and pressurizing sheets 93A and 94A, instead of the unit fuel batteries 6, collector sheets 91, electrical insulation sheets 92 and pressurizing sheets 93 and 94 used in the stack 9 of the past shown in Figure 9. The unit battery 6A uses separators 61A and 62A and fuel battery cell 8 instead of the separators 61 and 62 and fuel battery cell 7 used in the unit battery 6 shown in Figures 6-8. The separators 61A and 62A differ from the separators 61 and 62 in the fact that they each have four channels 611B and 621B. Furthermore, in the case where each of these channels 611B and 621B are differentiated, suffixes $_{A}$-$_{D}$ are added to the code number 611B or 621B as shown for the channel 621B in Figure 12.

{0029} Also, the fuel battery cell 8 differs from the fuel battery cell 7 in the fact that it has four pairs (for a total of 8) of through-holes 72 formed in the PE film not shown in the diagram, corresponding to the number of channels 611B and 621B. As shown in Figure 11, the pressurizing sheets 93A and 94A each have four piping connectors 98, which differs from the pressurizing sheets 93 and 94. Also, the pressurizing sheet 93A, collector sheet 91A and electrical insulation sheet 92A differ from the pressurizing sheet 93, collector sheet 91A and electrical insulation sheet 92 in the fact that through-holes not shown in the diagram are formed in locations opposite the respective through-holes 613B of the separator 61A, and the pressurizing sheet 94A, collector sheet 91A and electrical insulation sheet 92A differ from the pressurizing sheet 94, collector sheet 91 and electrical insulation sheet 92 in that through-holes not shown in the diagram are formed in locations opposite the respective through holes 624B of the separator 62A.

{0030} For this reason, the flow passage of the cooling fluid 99 in the stack 9A is basically the same as the flow passage of the cooling fluid 99 in the stack 9

explained using Figure 10 and so forth. The cooling fluid 99 in the stack 9A flows inside the stack 9A mainly by passages shown using the dotted lines and arrows in Figure 11. That is, the cooling fluid 99 flows into the stack 9A from the piping connector 98 (marked as "inlet" in Figure 11) attached to the pressurizing sheet 93A. Then, it flows into the layered body of unit batteries via the respective through-holes of the pressurizing sheet 93A, collector sheet 91A and electrical insulation sheet 92A formed in locations opposite the through-hole 613B formed in the channel $611B_A$, and it flows into the through-holes 613B, 72 and 623B connected to the channels $611B_A$ and $621B_A$, and is distributed in the channels $611B_A$ and $621B_A$ of the unit batteries 6A. Then, via the respective through-holes of the collector sheet 91A, electrical insulation sheet 92A and pressurizing sheet 94A formed in locations opposite the through-hole 624B formed in channel $621B_A$, and through-holes 614B, 72 and 624B connected to channels $611B_A$ and $621B_A$, it flows to outside the stack 9A from the piping connector 98 attached to the pressurizing sheet 94A.

{0031} This cooling fluid 99 that has flowed out flows in the piping 97, and then again flows into the stack 9A from the piping connector 98 attached to the pressurizing sheet 94A. This cooling fluid 99 flows into the channel $621B_B$ formed in the separator 62A of the unit battery 6A adjacent to the collector sheet 91A. Then, it is distributed in the channels $611B_B$ and $621B_B$ of the unit batteries 6A via through-holes 614B, 72 and 624B connected to channels $611B_B$ and $621B_B$, and then it flows to outside the stack 9A, via the respective through-holes of the collector sheet 91A, electrical insulation sheet 92A and pressurizing sheet 93A formed in locations opposite the through-hole 613B formed in the channel $611B_B$ and through holes 613B, 72 and 623B connected to the channels $611B_B$ and $621B_B$, from the piping connector 98 attached to the pressurizing sheet 93A. This procedure is repeated, and finally it is drained to outside the stack 9, via the

respective through holes of the collector sheet 91A, electrical insulation sheet 92A and pressurizing sheet 93A formed in locations opposite the through-hole 613B formed in the channel $611B_D$, and through-holes 613B, 72 and 623B connected to the channels $611B_D$ and $621B_D$, from the piping connector 98 (marked as "outlet" in Figure 11) attached to the pressurizing sheet 93A.

{0032} Furthermore, stacks that have a special cooling means instead of using separators that have channels through which cooling fluid 99 flow are also known.

{0033}

{Problems the Invention is to Resolve} In the solid high-polymer electrolyte fuel battery of the past described above, there are problems in sufficiently performing the function of DC power generation due to the fact that the fuel battery cells 7 and so forth are cooled by a cooling fluid 99 via separators and so forth, and a temperature suitable for stack operation is maintained. That is, in the stacks 9 and 9A of prior art, the distribution of temperature of fuel battery cells 7 that have unit batteries 6 and 6A in the direction of layering is high in the center in the direction of layering and is low at the two ends in the direction of layering, as shown in Figure 13. Here, Figure 13 is a graph that shows sample measurements of temperature distribution in a fuel battery cell that has unit batteries, in the direction of layering of the unit batteries of a solid high polymer electrolyte fuel battery of the past.

{0034} Due to the fact that the temperature distribution in the direction of layering of unit batteries is not uniform, in the fuel battery cells 7 and 8 that are at high temperature, the PE film 7C used in the fuel battery cells 7 and 8 dries up because evaporation of water is accelerated. On the other hand, due to the fact that the temperature distribution in the direction of layering of the unit batteries is not uniform, in the fuel battery cells 7 and 8 that are at low temperature, the

amount of evaporation of water is reduced in the fuel electrode 7A and oxidizer electrode 7B used in the fuel battery cells 7 and 8.

{0035} In the dried PE film 7C, the resistivity value increases due to the special characteristics of the PE film described above. When the resistivity of the PE film increases, the electrical resistance of the PE film increases, and therefore the joule loss in the fuel battery cells 7 and 8 increases, and their power generation efficiency decreases. Also, in the fuel electrode 7A and oxidizer electrode 7B whose surfaces are covered with water, this water seeps into the electrode and hinders diffusion of reaction gas in the electrode, and therefore power generation performance decreases.

{0036} The nonuniformity of temperature distribution in the direction of layering of unit batteries that brings about these reductions in performance of these stacks is caused by the fact that collector sheets 91 and 91A, pressurizing sheets 93 and 93A and pressurizing sheets 94 and 94A are attached on the two ends of the stacks 9 and 9A in the direction of layering of unit batteries, and the fact that there is only one fuel battery cell used as the fuel battery cell that is the object of cooling of the cooling means formed in the separators on the side of the collector sheet of the unit batteries located on the two ends of the stack in cases where unit batteries that use separators that have channels through which cooling fluid 99 flows are utilized as the unit batteries. That is, the electrically conductive material, such as copper, which is used in the collector sheets 91 and 91A, is also a good conductor of heat. Also, a metal such as steel is used in the pressurizing sheets 93, 93A, 94 and 94A due to considerations of mechanical strength, but these metals are also good conductors of heat. Because the presence of these good heat conductors increases the amount of thermal radiation from this location, the temperature at the two ends of the stacks 9 and 9A is decreased. Also, in a fuel battery cell that has unit batteries arranged on

both ends that are cooled on one side by a separator where only one fuel battery cell is cooled, the chance of being cooled is larger than that of the fuel battery cells arranged in other locations, and the temperature of these fuel battery cells decreases.

{0037} This invention takes a lesson from the problems of the prior art described above, and its purpose is to provide a solid high polymer electrolyte fuel battery in which the temperature distribution is easily made uniform in the direction of layering of the unit batteries.

{0038}

{Means for Resolving the Problems} The aforementioned purpose of this invention is achieved by the following means:

1) In a solid high polymer electrolyte fuel battery that has multiple unit fuel batteries that have a fuel battery cell that generates DC power by receiving a supply of fuel gas and oxidizer gas, and a pair of separators in which gas flow channels are formed for supplying fuel gas or oxidizer gas to the fuel battery cell and are arranged opposite the two main faces of the fuel battery cell, and these unit fuel batteries are made into a layered body of unit fuel batteries in which adjacent unit fuel batteries are layered with each other such that the side face on the reaction gas passage channel side of one separator is located opposite the side face on the reaction gas passage channel side of the separator of an adjacent unit fuel battery; and that has collector sheets made of electrically conductive material in contact with the outside faces of the separators located on at least both ends of the layered body of unit fuel batteries; and electrical insulation sheets of these collector sheets that are made of electrically insulating material and are in contact with the outside faces of the collector sheets located at least on both ends of the layered body of unit fuel batteries; and pressurizing sheets of these electrically insulating sheets that provide pressure force to the layered

body, collector sheets and electrical insulation sheets of the unit fuel batteries in the direction of layering, and that are in contact with the outside faces of the electrical insulation sheets located on at least the two ends of the layered body of unit fuel batteries; and piping connectors for cooling fluid provided in locations to supply and locations to drain cooling fluid that removes heat generated by the fuel battery cell; and the cooling fluid that removes heat generated by the fuel battery cell is supplied from outside the layered body of unit fuel batteries via a piping connector for supply of the cooling fluid, and after cooling the unit fuel batteries, is drained to outside the layered body of unit fuel batteries via a piping connector for drainage of the cooling fluid; a structure in which exothermic bodies heated by the electrical current output by the solid high polymer electrolyte fuel battery are formed at locations on the collector sheets that are in contact with the outside faces of the separators located at least on the two ends of the layered body of unit fuel batteries; or

2) In the means stated in item 1 above, a structure in which the exothermic bodies formed at locations on the collector sheets are exothermic bodies made of resistive material in the form of thin sheets sandwiched between the layered body of unit fuel cells and the collector sheets; or

3) In the means as stated in item 1 above, a structure in which the exothermic bodies formed at locations on the collector sheets are collector sheets made of resistive material; or

4) In a solid high polymer electrolyte fuel battery that has multiple unit fuel batteries that have a fuel battery cell that generates DC power by receiving a supply of fuel gas and oxidizer gas, and a pair of separators in which gas flow channels are formed for supplying fuel gas or oxidizer gas to the fuel battery cell and are arranged opposite the two main faces of the fuel battery cell, and these unit fuel batteries are made into a layered body of unit fuel batteries in which

adjacent unit fuel batteries are layered with each other such that the side face on the reaction gas passage channel side of one separator is located opposite the side face on the reaction gas passage channel side of the separator of an adjacent unit fuel battery; and that has collector sheets made of electrically conductive material in contact with the outside faces of the separators located on at least both ends of the layered body of unit fuel batteries; and electrical insulation sheets of these collector sheets that are made of electrically insulating material and are in contact with the outside faces of the collector sheets located at least on both ends of the layered body of unit fuel batteries; and pressurizing sheets of these electrically insulating sheets that provide pressure force to the layered body, collector sheets and electrical insulation sheets of the unit fuel batteries in the direction of layering, and that are in contact with the outside faces of the electrical insulation sheets located on at least the two ends of the layered body of unit fuel batteries; and piping connectors for cooling fluid provided in locations to supply and locations to drain cooling fluid that removes heat generated by the fuel battery cell; and the cooling fluid that removes heat generated by the fuel battery cell is supplied from outside the layered body of unit fuel batteries via a piping connector for supply of the cooling fluid, and after cooling the unit fuel batteries, is drained to outside the layered body of unit fuel batteries via a piping connector for drainage of the cooling fluid; a structure in which the collector sheets have heating means heated by the cooling fluid of which the temperature has been raised by cooling the unit fuel batteries; or

5) In the means as stated in item 4 above, a structure in which the heating means of the collector sheets are flow passages for cooling fluid, formed inside the collector sheets, through which flows cooling fluid of which the temperature has been raised by cooling of the unit fuel batteries.

{0039}

{Op ration} In this invention, in a solid high polymer electrolyte fuel battery (stack),

(1) due to the fact that it has a structure in which exothermic bodies that are heated by electrical current output by the stack, such as exothermic bodies made of resistive material in the form of thin sheets, are formed at locations of the collector sheets that are in contact with the outside faces of separators located on both ends of the layered body of unit fuel batteries (unit batteries)—for example, sandwiched between the layered body of unit batteries and the collector sheets—current output from the stack flows in the exothermic bodies, and as a result, joule heat is produced in the exothermic bodies in proportion to the product of the square of the current that flows in the exothermic bodies and the electrical resistance of the exothermic bodies. Due to the fact that the value of the joule heat generated by these exothermic bodies corresponds to the amount of heat radiated from the ends in the direction of layering of the unit batteries of the stack, the temperature distribution in the direction of layering of unit batteries can be made uniform.

{0040} (2) In item (1) above, due to the fact that the exothermic bodies formed at locations on the collector sheets are collector sheets made of resistive material, electrical current output from the stack flows to the collector sheets, and as a result, joule heat is produced in the collector sheets in proportion to the product of the square of the current that flows in the collector sheets and the electrical resistance of the collector sheets. Due to the fact that the value of the joule heat generated by these collector sheets corresponds to the amount of heat radiated from the ends in the direction of layering of the unit batteries of the stack, the temperature distribution in the direction of layering of unit batteries can be made uniform, similar to the case of item (1) above.

(3) This invention focuses on the fact that the cooling fluid that cools the stack is increased in temperature by cooling the stack, and the value of this temperature increase is about 10°C in the case of the stack of the example of the past. That is, due to the fact that the collector sheets have heating means that are heated by the cooling fluid of which the temperature has been raised by cooling the unit fuel batteries—for example, flow passages for cooling fluid through which flows cooling fluid of which the temperature has been raised by cooling of the unit fuel batteries formed inside the collector sheets—the collector sheets are well heated via the heating means by cooling fluid of which the temperature has been raised. Due to the fact that the amount of heat of the collector sheets heated by cooling fluid of which the temperature has been raised corresponds to the amount of heat radiated from the ends of the layered body of unit batteries of the stack, the temperature distribution in the direction of layering of the unit batteries can be made uniform.

{0041}

{Implementation Examples} Implementation examples of this invention are explained in detail below with reference to the diagrams.

Implementation Example 1: Figure 1 is a top-view diagram that schematically shows the structure of the major parts of a solid high polymer electrolyte fuel battery by an implementation example of this invention that corresponds to claim items 1 and 2. In Figure 1, the same code numbers are given to the same parts as the solid high polymer electrolyte fuel battery of the past shown in Figure 9, and therefore their explanations are omitted. Furthermore, only representative code numbers are shown for the code numbers used in Figures 6-10. In Figure 1, 1 is a solid high polymer electrolyte fuel battery (below abbreviated as stack) which differs from the solid high polymer electrolyte fuel battery of the past shown in Figure 9 in that thin-sheet

exothermic bodies 2 are sandwiched between the each collector sheet 91 and the unit fuel battery 6 that is adjacent to each respective collector sheet 91. The exothermic bodies 2 are thin sheets of resistive material such as electrothermic alloy material (whose volume resistivity is 1.0-1.5 μΩ-m), which is formed having the same surface area as the surface area direction dimension of the fuel electrode 7A and oxidizer electrode 7B, and the thickness of the exothermic bodies 2 is determined by the current output from the stack 1 such that the joule heat value produced by the exothermic bodies 2 is a value that corresponds to the heat quantity radiated from the ends in the layered direction of the stack 1.

{0042} In the implementation example shown in Figure 1, because it is constructed as described above, the current output from the stack 1 flows into the respective exothermic bodies 2 in their direction of thickness. For this reason, joule heat is produced in the exothermic bodies 2 in proportion to the product of the square of the current that flows from the stack 1 and the electrical resistance of the exothermic bodies 2, and the exothermic bodies function as electric heaters. The value of this joule heat generated from the exothermic bodies 2 nearly corresponds to the heat quantity radiated from the ends of the stack 1 in the direction of layering of the unit batteries 6, and it nearly cancels out the value of the joule heat generated by the respective exothermic bodies 2. Therefore, in the stack 1, the temperature of the fuel battery cells 7 of the respective unit batteries 6 can be made nearly the same value in the direction of layering of the unit batteries 6. Also, there is the advantage that it is not necessary to provide a separate power supply for electric heating for making the temperature distribution uniform in the direction of layering of the unit batteries 6, due to the fact that the output current of the stack 1 that flows the stack 1 is utilized.

{0043} **Impl m ntation example 2:** Figure 2 is a top-view diagram that schematically shows the structure of the important parts of a solid high polymer electrolyte fuel battery by an implementation example of this invention that corresponds to Claims 1 and 3. In Figure 2, the same code numbers are given to the same parts as the solid high polymer electrolyte fuel battery of the past shown in Figure 9, and therefore their explanations are omitted. Furthermore, in Figure 2, only representative code numbers are shown for the code numbers used in Figures 6-10. In Figure 2, 1A is a solid high polymer electrolyte fuel battery (referred to below as "stack") that uses collector sheets 3 instead of collector sheets 91 used in the solid high polymer electrolyte fuel battery 9 of the past shown in Figure 9. The collector sheets 3 are made using a resistive material such as thermoelectric alloy (whose volume resistivity is 1.0-1.5 μΩ-m). The electrical resistance value of the collector sheets 3 is determined so that the value of joule heat produced in the collector sheets 3 by current output from the stack 1A corresponds to the heat radiated from the ends in the direction of layering of the stack 1A.

{0044} In the implementation example shown in Figure 2, because it has the structure described above, current output from the stack 1A flows into the respective collector sheets 3. For this reason, joule heat is produced in the collector sheets 3 in proportion to the product of the square of the current that flows from the stack 1A and the electrical resistance of the collector sheets 3, and the collector sheets 3 function as electric heaters. The value of this joule heat generated from the collector sheets 3 nearly corresponds to the heat quantity radiated from the ends of the stack 1A in the direction of layering of the unit batteries 6, and it nearly cancels out the value of the joule heat generated by the respective collector sheets 3. Therefore, in the stack 1A, the temperature of the fuel battery cells 7 of the respective unit batteries 6 can be made nearly the same

value in the direction of layering of the unit batteries 6. Also, compared to the stack 1 by implementation example 1, the stack 1A by implementation example 2 has the advantage that the temperature distribution in the direction of layering of the unit batteries 6 can be made uniform without increasing the number of parts, because the exothermic bodies 2 are unnecessary. Furthermore, the stack 1A also has the advantage that it is not necessary to provide a separate power supply for electric heating for making the temperature distribution uniform in the direction of layering of the unit batteries 6, due to the fact that the output current of the stack 1A that flows the stack 1A is utilized.

{0045} **Implementation example 3:** Figure 3 is a top-view diagram that schematically shows the structure of the important parts of a solid high polymer electrolyte fuel battery by an implementation example of this invention that corresponds to Claims 4 and 5. Figure 4 (a) is an oblique diagram of one of the collector sheets shown in Figure 3 seen from the direction of arrow R in Figure 3, and Figure 4 (b) is this collector sheet seen from arrows A-A in Figure 4 (a). Also, Figure 5 (a) is a diagram of the other collector sheet shown in Figure 3 seen from the direction of arrow S in Figure 3, and Figure 5 (b) is this collector sheet seen from arrows B-B in Figure 5 (a). In Figure 3, the same code numbers are given to the same parts as in the solid high polymer electrolyte fuel battery of a different example of the past shown in Figure 11 and the collector sheets used in the solid high polymer electrolyte fuel battery of a different example of the past shown in Figure 11, and therefore their explanations are omitted. Furthermore, in Figure 3, only representative code numbers are shown for the code numbers used in Figures 4-12.

{0046} In Figure 3, 1B is a solid high polymer electrolyte fuel battery (referred to below as "stack") that uses collector sheets 4, collector sheets 5, pressurizing sheets 93B and electrical insulation sheets 92B instead of collector sheets 91A,

pressurizing sheets 93A on the side toward the "inlet" and "outlet" of cooling fluid 99, and electrical insulation sheets 92A, respectively, used in the solid high polymer electrolyte fuel battery 9A of the past shown in Figure 11. The collector sheet 4 differs from the collector sheet 91A in that it has holes with bottoms 42 instead of through-holes connected to the "outlet" of cooling fluid 99 inside the through-holes formed in locations opposite the respective through-holes 613B of the separators 61A, and it has boles with bottoms 43 and a flow passage 44 of the cooling fluid 99 which is the heater. That is, the collector sheet 4 has through-holes 41 in locations opposite the through-holes 613B formed in the channels 611B of the separator 61A. Among the through-holes 41, through-hole 41_A is formed in a location opposite through-hole 613B formed in channel $611B_A$, through-hole 41_B is formed in a location opposite through-hole 613B formed in channel $611B_B$, and through-hole 41_C is formed in a location opposite through-hole 613B formed in channel $611B_C$.

{0047} 45 and 45 are through-holes formed opposite through-holes 615A and 616A on the reaction gas inflow side among through-holes 615A and 616A of separator 61A. 46 is a terminal for extracting the output current of the stack 1B. A through-hole 47 formed in the terminal 46 is provided as necessary to allow passage of a fastening bolt 95, and a through-hole 48 is provided as necessary to attach a connector not shown in the diagram that extracts the output current. A hole with a bottom 42 is opened toward the side of the side face 4a that contacts the separator 61A, and a hole with a bottom 43 is opened toward the side opposite side face 4a. The two holes with bottoms 42 and 43 are joined inside the collector sheet 4, and a flow passage 44 of cooling fluid 99 is formed as shown in the diagram. Also, this hole with a bottom 42 is formed in a location opposite the through-hole 613B formed in the channel $611B_D$ of the separator 61A.

{0048} The collector sheet 5 differs from the collector sheet 91A in that a hole with a bottom 52 is provided instead of the through-hole that connects to the channel $621B_C$ of the separator 62A inside the through-hole formed in locations opposite the through-holes 624B, and a hole with a bottom 53 is provided instead of the through-hole that connects to the channel $621B_D$ of the separator 62A, and a flow passage 54 of cooling fluid 99 which is a heater is provided. That is, in the collector sheet 5, through-holes 51 are formed in locations opposite the through-holes 624B formed in the channels 621B of the separator 62A. Among these through-holes 51, through-hole 51_A is formed in a location opposite through-holes 624B formed in the channel $621B_A$, and through-hole 51_B is formed in a location opposite through-holes 624B formed in the channel $621B_B$. 55 and 55 are through-holes formed opposite through-holes 625A and 626A on the reaction gas outflow side among through-holes 625A and 626A of separator 62A. 56 is a terminal for extracting the output current of the stack 1B, similar to the terminal 46 of the collector sheet 4. A through-hole 57 formed in the terminal 56 is provided as necessary to allow passage of a fastening bolt 95, and a through-hole 58 is provided as necessary to attach a connector not shown in the diagram that extracts the output current. A hole with a bottom 52 and a hole with a bottom 53 are opened toward the side of the side face 5a that contacts the separator 62A. The two holes with bottoms 52 and 53 are joined inside the collector sheet 5, and a flow passage 54 of cooling fluid 99 is formed as shown in the diagram.

{0049} The pressurizing sheet 93B and electrical insulation sheet 92B differ from the pressurizing sheet 93A and the electrical insulation sheet 92A in that through-holes are formed in locations opposite the holes with bottoms 43 of the collector sheet 4. Also, a piping connector 98 of the "outlet" of cooling fluid 99 is attached to the pressurizing sheet 93B in the locations of these through-holes of pressurizing sheet 93B.

{0050} The flow passage of the cooling fluid 99 in stack 1B constructed as described above is exactly the same as the flow passage of cooling fluid 99 in stack 9A, as far as the fact that cooling fluid 99 flows in through-holes 613B, 72 and 623B connected to channels $611B_C$ and $621B_C$ of the respective unit batteries 6A, and it branches in the respective channels $611B_C$ and $621B_C$, and it flows in the through-holes 614B, 72 and 624B connected to channels $611B_C$ and $621B_C$, and then it flows out from through-hole 624B of the channel $621B_C$ formed in the separator 62A of the unit battery 6A adjacent to the collector sheet 5.

{0051} In the stack 1B, after the cooling fluid 99 flows out from the through-holes 624B of the channel $621B_C$, it flows in the following path. That is, first, it flows inside the flow passage 54 of the collector sheet 5 from the holes with bottoms 52 of the collector sheet 5, then it flows into the layered body of unit batteries via through-holes 624B of the unit batteries 6A from the holes with bottoms 53 of the collector sheet 5. Therefore, piping connector 98 and piping 97 are unnecessary in this path.

{0052} Similar to the case of the stack 9A, the cooling fluid 99 that has re-entered the layered body of unit batteries from the through-holes 624B of the channel $621B_D$ flows in the through-holes 641B, 72 and 624B connected to the channels $611B_D$ and $621B_D$, and it branches in the channels $611B_D$ and $621B_D$, and it flows into the through-holes 613B, 72 and 623B connected to the channels $611B_D$ and $621B_D$, and then flows out from the through-holes 613B of the channel $611B_D$ formed in the separator 61A of the unit battery 6A adjacent to the collector sheet 4. In the stack 1B, the cooling fluid 99 that has flows out from the through-holes 613B of the channel 611BD flows from the hole with bottom 42 of the collector sheet 4 into the flow passage 44 of the collector sheet 4, and then it flows from the hole with bottom of the collector sheet 4 into a through-hole opposite the hole with bottom 43 formed in the electrical insulation sheet 92B. Then, it is

drained to outside the stack 1B from an "outlet" piping connector 98 attached in the location of the through-hole opposite the hole with bottom 43 formed in the pressurizing sheet 93B.

{0053} In the implementation examples shown in Figures 3-5, because they have the structure described above, the cooling fluid 99 of which the temperature has been raised by flowing through the layered body of unit batteries 6A flows inside the flow passages 44 and 54 which are heating means of the collector sheets 4 and 5. The amount of temperature rise of this cooling fluid 99 is about 10°C as described in the Operation section. On the other hand, the temperature difference of the fuel battery cells of each unit battery in the direction of layering of the unit batteries, which was a problem in the case of the stack of prior art, is about 5°C as shown in Figure 13. Therefore, if the cooling fluid that cooled the stack that has this temperature rise of 10°C is used, the temperature difference of the fuel battery cells of each unit battery in the direction of layering of the unit batteries can be reduced without using a separate heating source.

{0054} That is, the collectors sheets 4 and 5 that have flow passages 44 and 54 as shown in the diagram are made of electrically conductive material that is also a good conductor of heat, and they are heated across the entire surface and are well heated by the cooling fluid 99 due to the fact that the cooling fluid 99 of which the temperature was raised flows in these flow passages 44 and 54. As a result, the difference in temperature in the direction of layering of the unit batteries 6A can be reduced. Also, the electrical insulation sheets 92A and 92B used in the stack 1B are made using electrically insulating material, and this electrically insulating material generally has smaller thermal conductivity than the electrically conductive material used in the collector sheets 4 and 5. In such a case, the heating of the collector sheets 4 and 5 can be performed efficiently by

the heat of the cooling fluid 99 of which the temperature was raised, which does not have a large temperature difference from the temperature of the unit batteries 6A. This is very beneficial in heating the collector sheets 4 and 5 by cooling fluid 99 of which the temperature was raised.

{0055} Also, the structure of the stack 1B also has the advantage that it is not necessary to separately provide piping and piping connectors in the attempt to reduce the temperature difference of the fuel battery cells of each unit battery in the direction of layering of the unit batteries, because the cooling fluid 99 of which the temperature was raised can be made to flow directly into the flow passages 44 and 54 formed in the collector sheets 4 and 5. Also, compared to the stacks 1 and 1A of implementation examples 1 and 2, the stack 1B of implementation example 3 makes it unnecessary to generate joule heat inside exothermic bodies 2 in stack 1 in the attempt to make the temperature distribution uniform in the direction of layering of the unit batteries 6A due to the fact that the cooling fluid 99 of which the temperature has been raised can be utilized. As a result, there is the advantage that the output power of the stack 1B can be increased at least by the amount of this joule heat.

{0056} In the explanation of implementation example 3 up to this point, the collector sheets 4 and 5 have special flow passages 44 and 54, but they are not limited to this. For example, for the flow passages through which flows the cooling fluid 99 of which the temperature has been raised of the collector sheets 4 and 5, it is possible to appropriately set the shape of the flow passages, the piping locations, the division of the flow passages into multiple branches, and the locations of the inlet and output of the cooling fluid 99 in the collector sheets 4 and 5 depending on conditions such as the temperature distribution in the direction of surface area of the fuel battery cells, the temperature increase value between the "inlet" and "outlet" of the cooling fluid 99, and configuration of the

stack, and the temperature differential in the direction of layering of the unit batteries of the stack in the center of the fuel battery cells of each unit battery.

{0057} Also, in the explanation of implementation example 3 up to this point, the heating means provided in the collector sheets of the solid high polymer electrolyte fuel battery is flow passages of the cooling fluid 99 formed inside the collector sheets, but it is not limited to this. For example, it can be a heater that is heated by the cooling fluid 99 adjacent to the collector sheets. Also, in the explanation of implementation example 3 up to this point, in the layered body of unit batteries 6A, the cooling fluid 99 flows through a cooling means formed in the separators 61A and 62A of the unit batteries 6A, but it is not limited to this. For example, for the unit batteries, it is possible to use separators that do not have a cooling means through which the cooling fluid 99 flows, but instead to use a special cooling body. The cooling fluid 99 that flows through this special cooling body flows through suitable piping, and is supplied the collector sheets or a heating body that is heated by the cooling fluid 99 adjacent to the collector sheets.

{0058} In the explanations of implementation examples 1-3 up to this point, implementation example 3 attempts to reduce the temperature difference in the direction of layering of the unit batteries using only the structure according to implementation example 3, but it is not limited to this. For example, it can use a structure that utilizes both implementation example 3 as well as implementation example 1 or 2.

{0059}

{Effect of the Invention} In this invention, the following effects are displayed due to the structure described above.

(1) The temperature distribution in the direction of layering of unit fuel batteries can be made uniform; also,

(2) From item (1) above, the problem of an increase in resistivity of the solid high polymer electrolyte film due to drying of the solid high polymer electrolyte film and the problem of hindrance of diffusion of reaction gas in the electrode due to seepage of water into the electrode are resolved, and it is possible to improve various types of performance such as output performance of the solid high polymer electrolyte fuel battery; also

(3) In obtaining the effects of items (1) and (2) above, it is not necessary to provide a separate heating source or power supply for heating, and therefore a solid high polymer electrolyte fuel battery in which various types of performance such as the aforementioned output performance are improved can be obtained with only a slight increase in manufacturing costs; also,

(4) In obtaining the effects of items (1)-(3) above, there is no increase in the number of parts due to the fact that the exothermic bodies formed in locations on the collector sheets are collector sheets made of resistive material, and therefore a solid high polymer electrolyte fuel battery in which various types of performance such as the aforementioned output performance are improved can be obtained with inexpensive manufacturing costs; and also,

(5) In obtaining the effects of items (1)-(3) above, the output value of the aforementioned solid high polymer electrolyte fuel battery can be improved because it is unnecessary to generate joule heat to make the temperature distribution uniform in the direction of layering of the unit fuel batteries due to the fact it is a structure that has a heater by which the collector sheets are heated by cooling fluid of which the temperature has been increased by cooling the unit fuel batteries—for example, a flow passage for cooling fluid in which cooling fluid of which the temperature has been increased by cooling of the unit fuel batteries formed inside the collector sheet.

{Brief Explanation of the Diagrams}

{Figure 1} Top-view diagram that schematically shows the important parts of the structure of a solid high polymer electrolyte fuel battery by an implementation example of this invention that corresponds to Claims 1 and 2

{Figure 2} Top-view diagram that schematically shows the important parts of the structure of a solid high polymer electrolyte fuel battery by an implementation example of this invention that corresponds to Claims 1 and 3

{Figure 3} Top-view diagram that schematically shows the important parts of the structure of a solid high polymer electrolyte fuel battery by an implementation example of this invention that corresponds to Claims 4 and 5

{Figure 4} (a) is an oblique diagram of one of the collector sheets shown in Figure 3 seen from the direction of arrow R in Figure 3, and (b) is this collector sheet seen from arrows A-A in Figure 4 (a)

{Figure 5} (a) is a diagram of the other collector sheet shown in Figure 3 seen from the direction of arrow S in Figure 3, and (b) is this collector sheet seen from arrows B-B in Figure 5 (a)

{Figure 6} Side-view cross-sectional diagram that schematically shows, in the exposed state, the important parts of a general example of a unit fuel battery of a solid high polymer electrolyte fuel battery

{Figure 7} Oblique diagram that schematically shows the unit fuel battery of Figure 6 in the exposed state

{Figure 8} Diagram of a separator of the unit fuel battery seen from the direction of arrow P in Figure 6

{Figure 9} Structural diagram that schematically shows the major parts of a solid high polymer electrolyte fuel battery of the past, where (a) is a side-view diagram, and (b) is a top-view diagram

{Figure 10} Explanatory diagram that explains the cooling fluid flow passages provided in the solid high polymer electrolyte fuel battery shown in Figure 9

{Figure 11} Top-view diagram that schematically shows the structure of the major parts of a different solid high polymer electrolyte fuel battery of the past

{Figure 12} Diagram of the separator used in Figure 11 as seen from the direction of arrow Q in Figure 11

{Figure 13} Graph that shows sample measurements of temperature distribution in a fuel battery cell that has unit batteries, in the direction of layering of the unit batteries of a solid high polymer electrolyte fuel battery of the past.

{Key to Figures}

1 Solid high polymer electrolyte fuel battery (stack)
2 Exothermic body
6 Unit battery
91 Collector sheet

{Figure 1} Key:

1 Solid high polymer electrolyte fuel battery (stack)
2 Exothermic body
6 Unit battery
91 Collector sheet
Top left: "Inlet"
Bottom left: "Outlet"

{Figure 3} Key:

Bottom left: "Outlet"

{Figure 13} Key

Y-axis label: Temperature at center of fuel battery cell
X-axis label: Position of fuel battery cell
One end of stack Center of stack Other end of stack

{Figure 10} K y

Bottom left: "Inlet"
Bottom right: "Outlet"

{Figure 11} Key

Top left: "Inlet"
Bottom left: "Outlet"

成とすることにより、部品点数の増加が発生しないので、前記した出力性能等の諸性能が向上された固体高分子電解質型燃料電池を、安価な製造原価により得ることが可能となる。さらにまた、

⑤前記①～③項による効果を得るに当たり、集電板を、単位燃料電池を冷却することで温度が上昇した冷却用流体で加熱される、例えば、集電板内に形成され，単位燃料電池を冷却することで温度が上昇した冷却用流体を通流させる冷却用流体用の通流路である等の、加熱部を備える構成とすることにより、単位燃料電池の積層方向における温度の分布の均一化を図るためにジュール熱の発生が不要となるので、前記した固体高分子電解質型燃料電池の出力値をさらに向上することが可能となる。

【図面の簡単な説明】

【図1】請求項1，2に対応するこの発明の一実施例による固体高分子電解質型燃料電池の要部の構成を模式的に示したその上面図

【図2】請求項1，3に対応するこの発明の一実施例による固体高分子電解質型燃料電池の要部の構成を模式的に示したその上面図

【図3】請求項4，5に対応するこの発明の一実施例による固体高分子電解質型燃料電池の要部の構成を模式的に示したその上面図

【図4】図3中に示した一方の集電板の、（a）は一部破断して図3におけるR矢方向から見た図、（b）は図4（a）におけるA－A矢視図

【図5】図3中に示した他方の集電板の、（a）は一部破断して図3におけるS矢方向から見た図、（b）は図5（a）におけるB－B矢視図

【図6】固体高分子電解質型燃料電池が備える一般例の単位燃料電池を展開した状態で模式的に示した要部の側面断面図

【図7】図6に示した単位燃料電池を展開した状態で模式的に示した斜視図

【図8】単位燃料電池が有するセパレータを図6におけるP矢方向から見た図

【図9】従来例の固体高分子電解質型燃料電池を模式的に示した要部の構成図で，（a）はその側面図、（b）はその上面図

【図10】図9中に示した固体高分子電解質型燃料電池に与える冷却用流体の通流路を説明する説明図

【図11】異なる従来例の固体高分子電解質型燃料電池を模式的に示した要部の構成を示す上面図

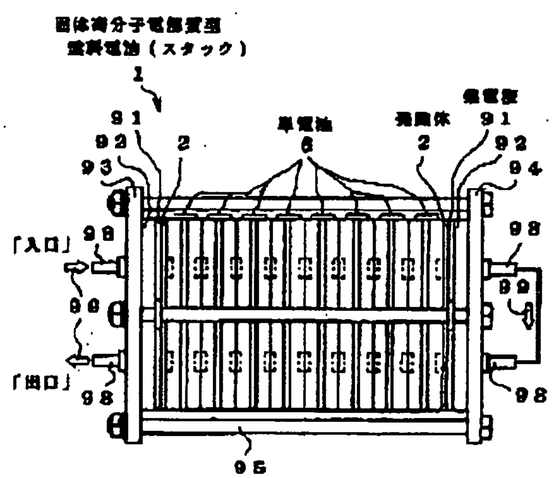
【図12】図11において用いられているセパレータを図11におけるQ矢方向から見た図

【図13】従来例の固体高分子電解質型燃料電池の単位燃料電池積層方向における、各単位燃料電池が持つ燃料電池セルの面積方向における中心部の温度分布の測定例を示すグラフ

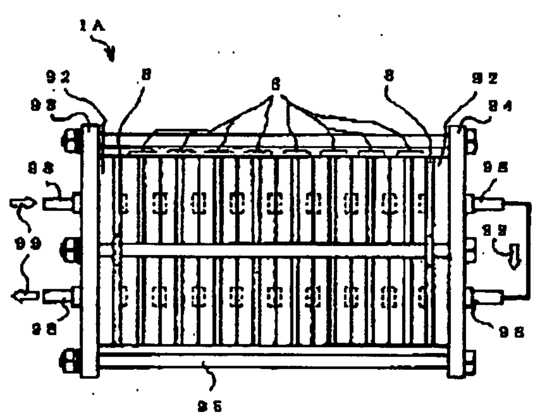
【符号の説明】

1　固体高分子電解質型燃料電池（スタック）
2　発熱体
6　単電池
91　集電板

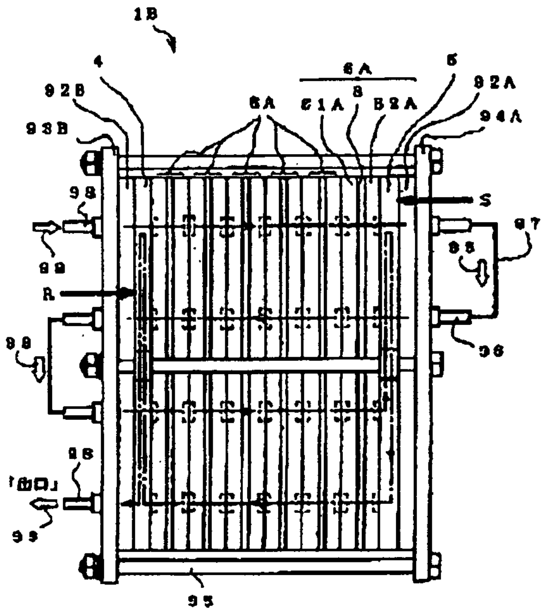
【図1】



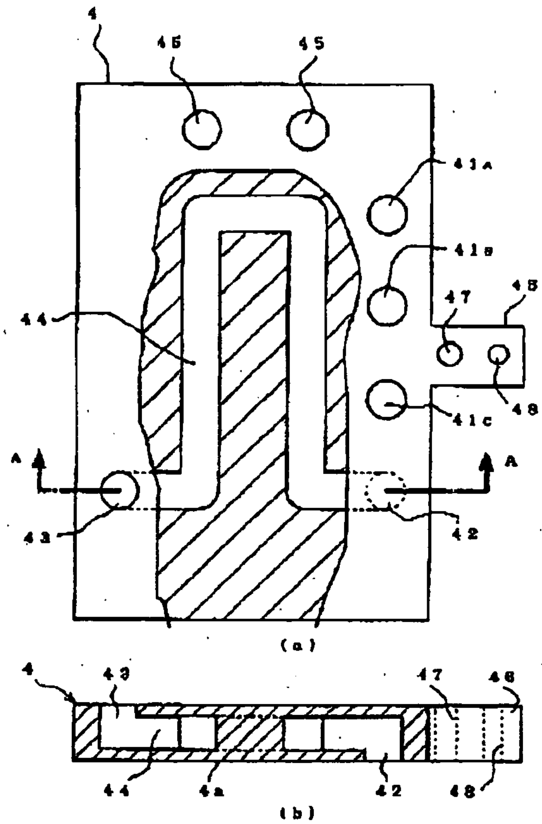
【図2】



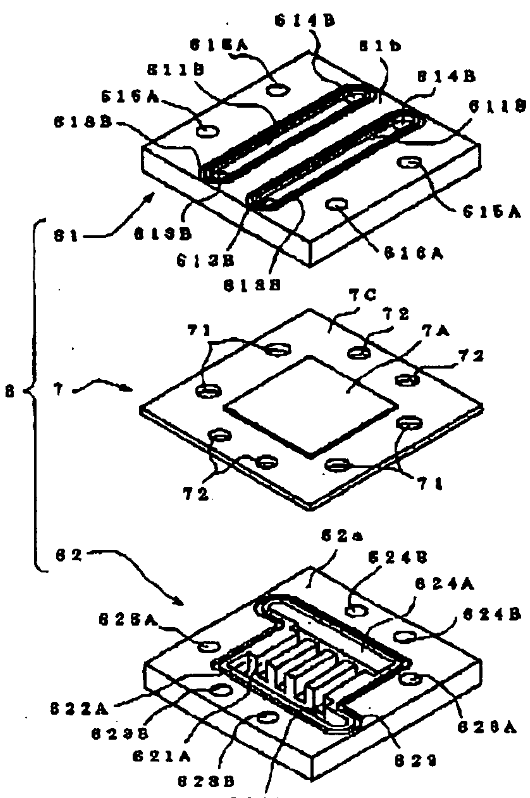
【図3】


1B
4
92B
93B
6A
6A
5
61A
8
62A
92A
94A
S
98
97
99
95
R
99
96
98
「出口」
99
95

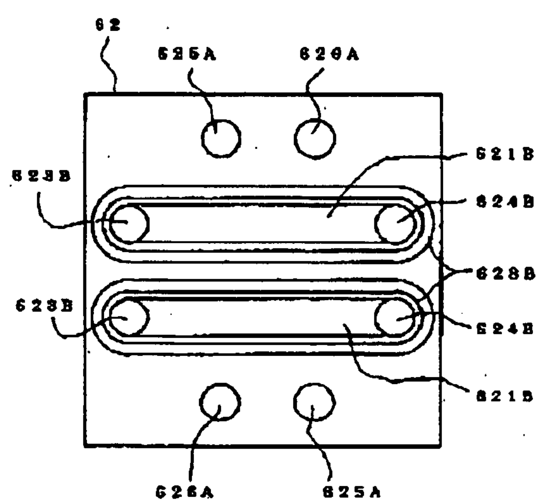
【図4】


4
45
45
41A
41B
47
46
44
48
41C
A
A
43
42
(a)
4
43
47
46
44
4a
42
48
(b)

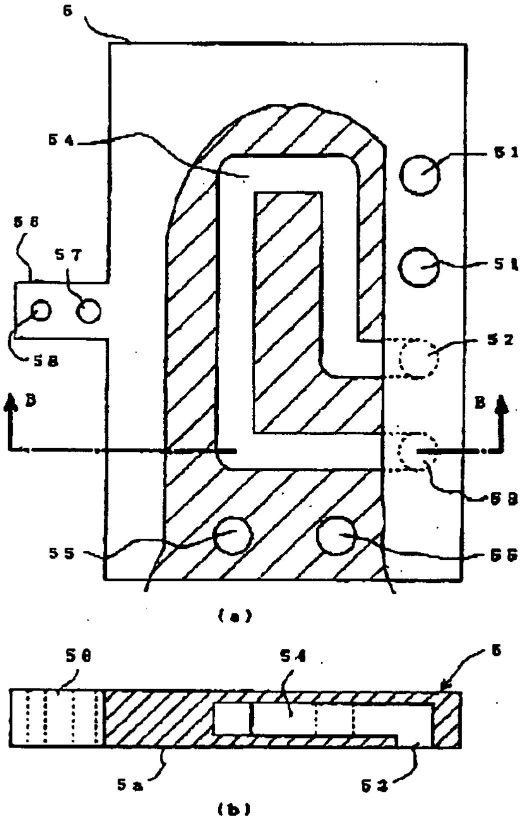
【図7】


614B
615A
61b
611B
614B
616A
611B
613B
615A
61
613B
616A
612B
613B
7C
72
71
7A
72
8
7
72
71
62
62a
624B
624A
625A
624B
622A
626A
623B
621A
623B
629
624A

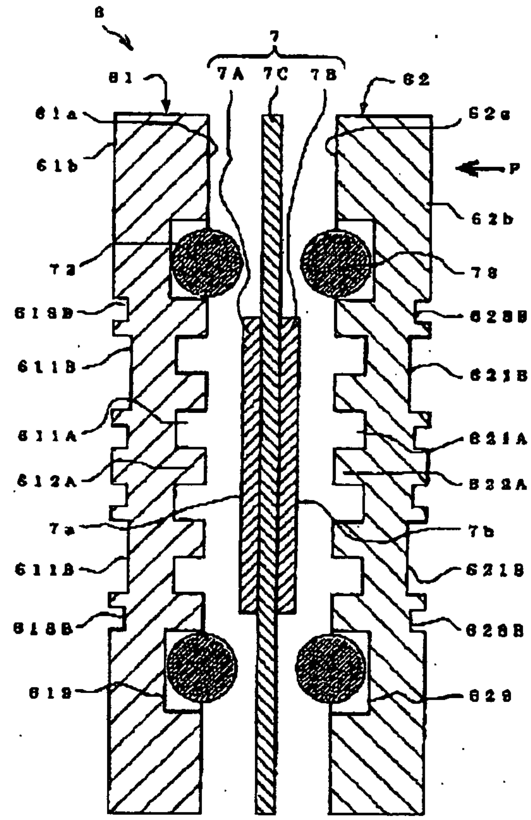
【図8】


62
625A
626A
621B
623B
624B
628B
623B
624B
621B
626A
625A

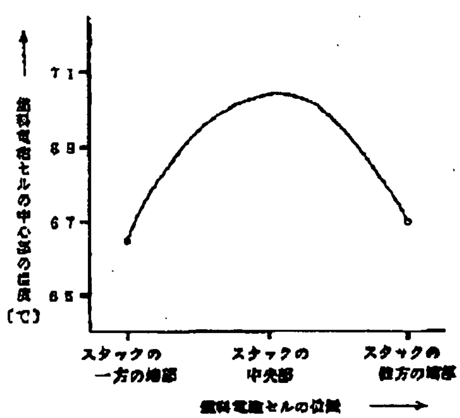
【図5】


5
54
51A
51B
56
57
58
52
B
B
53
55
55
(a)
56
54
5
5a
53
(b)

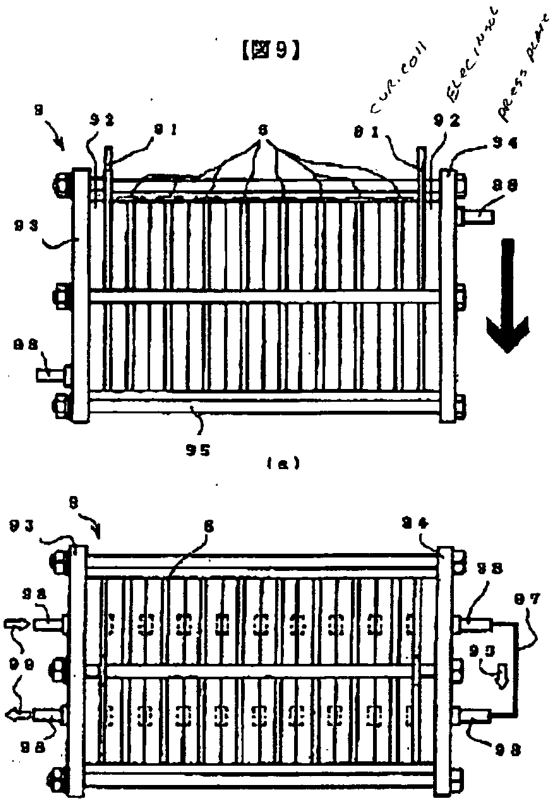
【図6】


6
7
61
7A
7C
7B
62
61a
62a
61b
P
62b
72
78
613B
623B
611B
621B
611A
621A
612A
622A
7a
7b
611B
621B
613B
623B
619
629

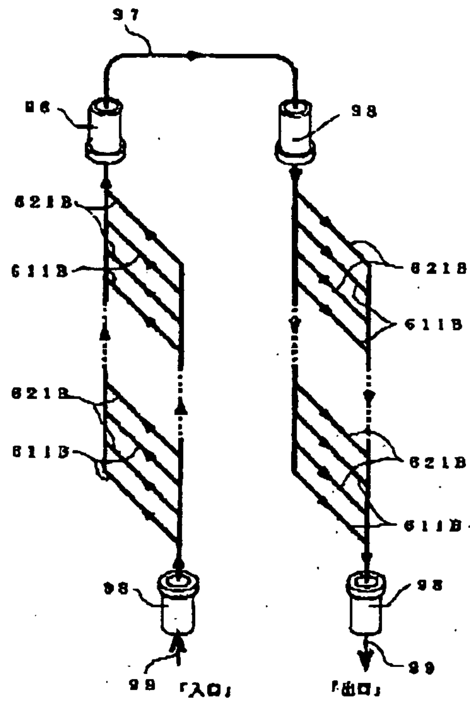
【図13】


71
69
67
65
(℃)
スタックの
一方の端部
スタックの
中央部
スタックの
他方の端部
燃料電池セルの位置

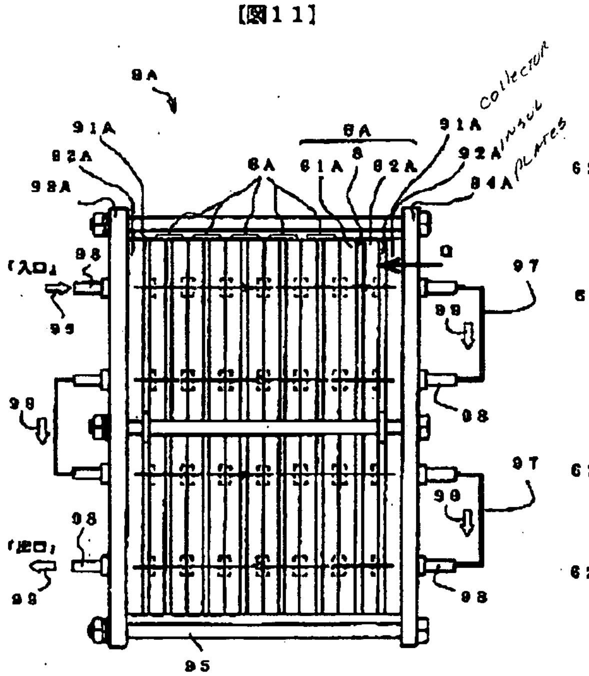
【図9】



【図10】



【図11】



【図12】